American River Basin: Upper Unionhouse Creek Flood Protection Project

Attachment 7: Economic Analysis – Flood Damage Reduction Costs and Benefits

Contents

Summary

Unionhouse Creek is a tributary to Morrison Creek in the southern part of the City of Sacramento (City) and in unincorporated Sacramento County (County). As shown in Figure 1, the two creeks converge just to the west of the Union Pacific Railroad (UPRR) line about one-half mile north of the Sacramento Regional Waste Water Treatment Plant (Treatment Plant). East of Franklin Boulevard, the creek is confined to an excavated channel. Hydraulic modeling studies indicate that the portion of the channel between Franklin Boulevard and Center Parkway floods out of bank in 100-year and more frequent storms. The flows exiting the channel inundate low lying urban neighborhoods on both sides of the creek. As shown in the flood plain map attached as Figure 2, the inundated area north of the creek is larger than the inundated area south of the creek. The modeling studies indicate that approximately 250 to 300 homes in the inundation area will suffer damage in the event of a 100-year flood.

The Sacramento Area Flood Control Agency (SAFCA) proposes to address the existing flood risk along Unionhouse Creek by expanding the width and adjusting the depth of the existing channel between Franklin Boulevard and Bruceville Road. Between Strawberry Creek immediately downstream of Bruceville Road and Center Parkway, the existing 2,800-foot trapezoidal channel would be widened to the south by up to 17 feet to a width of 75 feet with a new 2H:1V side slope and a widened channel bottom of up to 26.25 feet. The existing concrete channel bottom in this reach of the creek would be left in place for continued maintenance of the channel, and a concrete curb would be added between the concrete bottom and the earthen bottom. Between Center Parkway and Franklin Boulevard, the existing 5,400 foot trapezoidal channel would be widened to the south by up to 17 feet to a width of 75 feet with a new 2H:1V:side slope. The existing concrete channel bottom would be demolished and removed, the channel would be slightly deepened and a new concrete bottom would be installed across the width of the widened channel, which could be up to 24.5 feet.

This project would significantly reduce the likelihood of overbank flooding in this portion of the creek and would provide at least a 100-year level of flood protection to the lands adjacent to the creek in this

area thus removing the 250 to 300 homes from the regulated floodplain and protecting the homeowners from future potential flood damage.

Costs

As documented in Attachment 4, the budgetary estimate for the Project is $1,953,546. Table 1 augments the costs presented in Attachment 4 with projected future operations, maintenance and replacement costs. The total present value of the project is $1,934,031 and is based on a 50-year project life cycle, which is consistent with the life cycle assumed in the flood damage reduction benefit analysis. The annual maintenance costs for the project are estimated to be $20,000 and includes erosion repair, a two man crew mowing the banks of the creek twice a year, cleaning the bottom of the channel and other site-specific maintenance. There are no administration, operation or replacements costs assumed for this project as the project is a passive project (that is, no ongoing administrative or operations actions are required as part of project implementation).

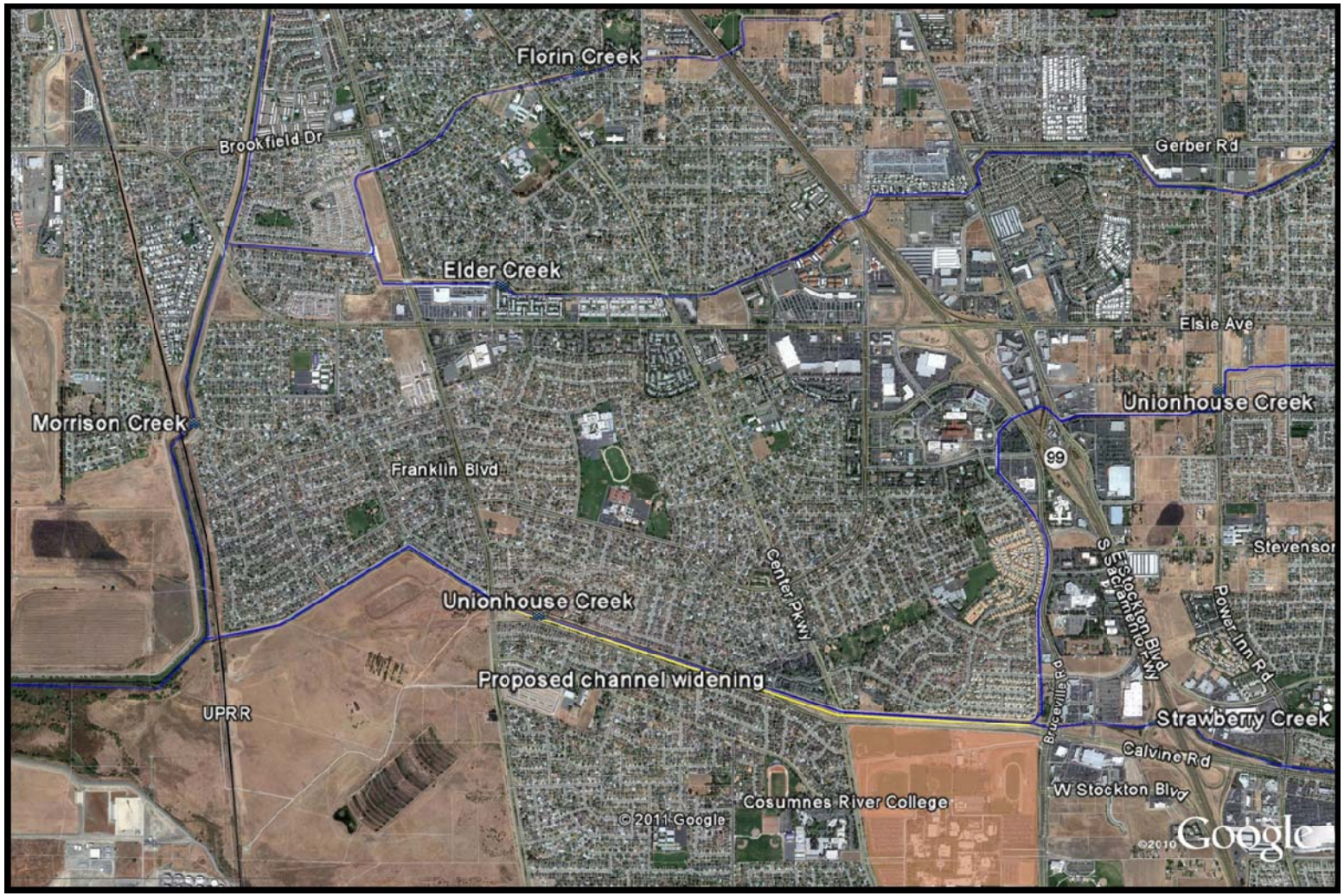

Figure 1: Location of Upper Unionhouse Creek Flood Protection Project

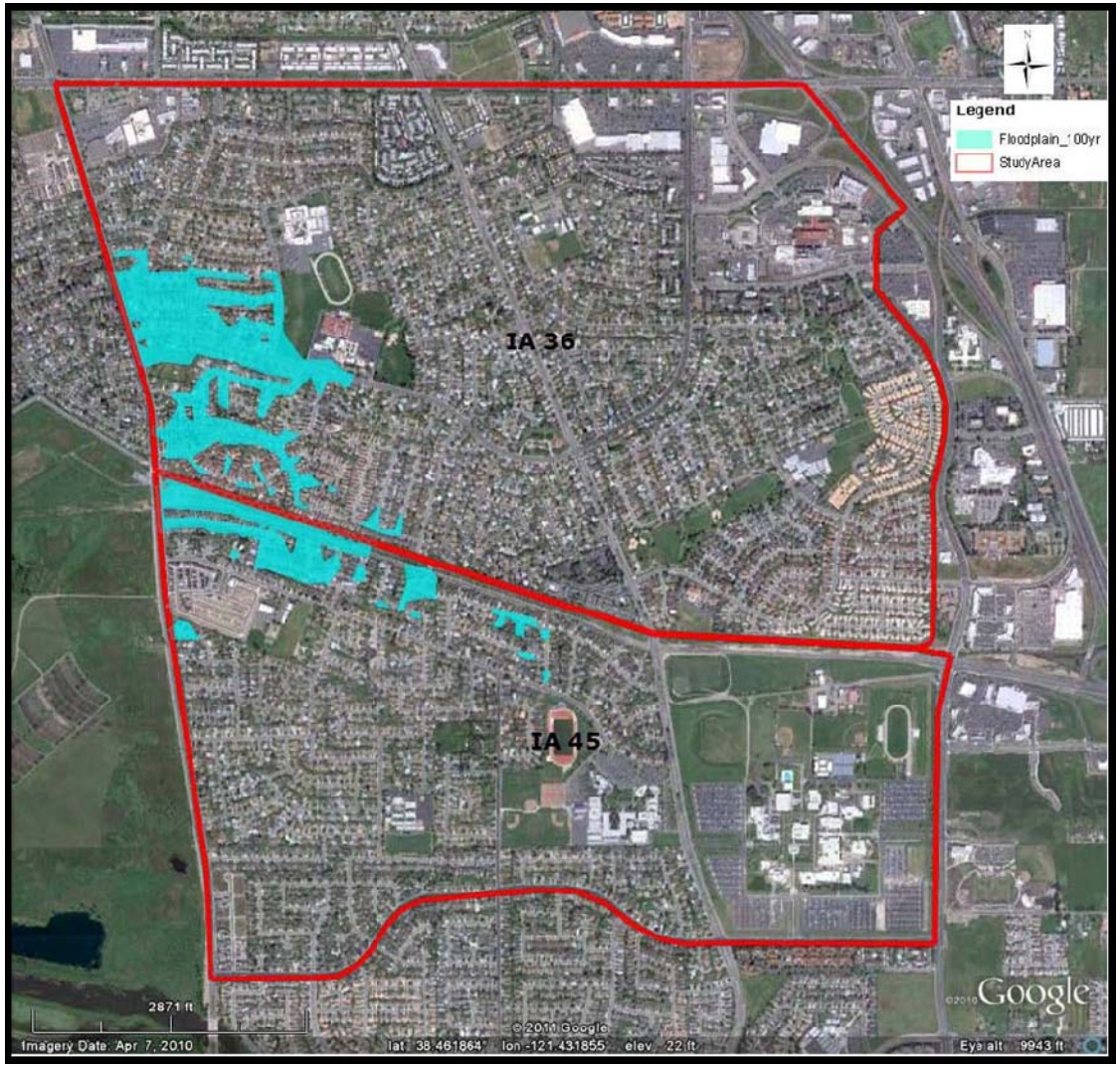

Figure 2: 100-Year Flood Inundation without the Upper Unionhouse Creek Flood Protection Project

Table 1: Annual Cost of Project (referenced as Table 10 in Exhibit C of the Proposition 1E Grant PSP)

Annual Cost of Project Project: Upper Unionhouse Creek Flood Protection Project									
	Initial Costs	Operations and Maintenance Costs (1)						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total cost From Attachment 4 Project 5 (row (i), column (d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +...+ (f)	Discount Factor	Discounted Costs (g) x (h)
2009							$0.00	1.000	$0
2010							$0.00	0.943	$0
2011	$ 566,479						$566,479.00	0.890	$504,166
2012	$ 1,387,067						$1,387,067.00	0.840	$1,165,136
2013				$20,000			$20,000.00	0.792	$15,840
2014				$20,000			$20,000.00	0.747	$14,940
2015				$20,000			$20,000.00	0.705	$14,100
2016				$20,000			$20,000.00	0.665	$13,300
2017				$20,000			$20,000.00	0.627	$12,540
2018				$20,000			$20,000.00	0.592	$11,840
2019				$20,000			$20,000.00	0.558	$11,160
2020				$20,000			$20,000.00	0.527	$10,540
2021				$20,000			$20,000.00	0.497	$9,940
2022				$20,000			$20,000.00	0.469	$9,380
2023				$20,000			$20,000.00	0.442	$8,840
2024				$20,000			$20,000.00	0.417	$8,340
2025				$20,000			$20,000.00	0.394	$7,880
2026				$20,000			$20,000.00	0.371	$7,420
2027				$20,000			$20,000.00	0.350	$7,000
2028				$20,000			$20,000.00	0.331	$6,620
2029				$20,000			$20,000.00	0.312	$6,240
2030				$20,000			$20,000.00	0.294	$5,880
2031				$20,000			$20,000.00	0.278	$5,560
2032				$20,000			$20,000.00	0.262	$5,240

Annual Cost of Project Project: Upper Unionhouse Creek Flood Protection Project									
	Initial Costs	Operations and Maintenance Costs (1)						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total cost From Attachment 4 Project 5 (row (i), column (d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +…+ (f)	Discount Factor	Discounted Costs (g) x (h)
2033				$20,000			$20,000.00	0.247	$4,940
2034				$20,000			$20,000.00	0.233	$4,660
2035				$20,000			$20,000.00	0.220	$4,400
2036				$20,000			$20,000.00	0.207	$4,140
2037				$20,000			$20,000.00	0.196	$3,920
2038				$20,000			$20,000.00	0.185	$3,700
2039				$20,000			$20,000.00	0.174	$3,480
2040				$20,000			$20,000.00	0.164	$3,280
2041				$20,000			$20,000.00	0.155	$3,100
2042				$20,000			$20,000.00	0.146	$2,920
2043				$20,000			$20,000.00	0.138	$2,760
2044				$20,000			$20,000.00	0.130	$2,600
2045				$20,000			$20,000.00	0.123	$2,460
2046				$20,000			$20,000.00	0.116	$2,320
2047				$20,000			$20,000.00	0.109	$2,180
2048				$20,000			$20,000.00	0.103	$2,060
2049				$20,000			$20,000.00	0.097	$1,940
2050				$20,000			$20,000.00	0.092	$1,840
2051				$20,000			$20,000.00	0.087	$1,740
2052				$20,000			$20,000.00	0.082	$1,640
2053				$20,000			$20,000.00	0.077	$1,540
2054				$20,000			$20,000.00	0.073	$1,460
2055				$20,000			$20,000.00	0.069	$1,380
2056				$20,000			$20,000.00	0.065	$1,300
2057				$20,000			$20,000.00	0.061	$1,220
2058				$20,000			$20,000.00	0.058	$1,160

Annual Cost of Project

Project: Upper Unionhouse Creek Flood Protection Project

	Initial Costs	Operations and Maintenance Costs (1)						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total cost From Attachment 4 Project 5 (row (i), column (d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +…+ (f)	Discount Factor	Discounted Costs (g) x (h)
2059				$20,000			$20,000.00	0.054	$1,086
2060				$20,000			$20,000.00	0.051	$1,024
2061				$20,000			$20,000.00	0.048	$966
2062				$20,000			$20,000.00	0.046	$912
2063				$20,000			$20,000.00	0.043	$860
							Total Present Value of Discounted Costs (Sum of Column (i))		$1,934,031

Comments: The project is a passive project, therefore there are no regular administrative or operational costs.

The "Without Project" Baseline

Without the proposed project, the likelihood of overbank flooding will remain the same and 250 to 300 homes will remain in the floodplain. Additionally, the Sacramento Regional Transit Authority may not be able to complete the light rail service from downtown Sacramento to Cosumnes River College due to the threat of overbank flooding.

Flood Damage Reduction Benefits

This section describes the Flood Damage Reduction Analysis (FDRA) that was completed for the Project and presents the Expected Annual Damage (EAD) benefits that would result from the completion of the Project. The tasks performed to determine the EAD and inundation-reduction (IR) benefit included:

1. Coordinated with the project team to define the conditions of the study, including the without-project condition (no channel improvements) and the with-project condition (completion of channel improvements).
2. Identified impact areas for the IR benefit analysis, which are delineations of the study area.
3. Identified index points for each impact area. The hydrologic and hydraulic characteristics of an index point represent those characteristics for a reach of stream adjacent to the impact area.
4. Developed an elevation-damage function for each impact area. Information developed by the Corps as part of its American River economic reevaluation report was used (ERR) (USACE 2007). Specifically, the structure inventory, structure values, and depth-percent damage functions from the Corps' ERR study. The structure values to current dollars were updated using the Engineering News-Record construction cost index.
5. Developed the required hydrologic and hydraulic input at each index point. For this, existing hydrologic and hydraulic models and their associated boundary conditions were used. Specifically, the SacCalc and HEC-RAS models provided by Sacramento County were used. The SacCalc model was used to develop the discharge-probability function at the index point and the HEC-RAS model was used to develop the discharge-elevation functions.
6. Developed the required exterior-interior elevation functions for each impact area. Existing hydrologic and hydraulic models and topographic data provided by Sacramento County were once again used.
7. Computed expected annual damages (EAD) for each impact area and for the study area as a whole using computer program HEC-FDA.
8. Computed the IR benefit for the study area.

Hydrology and Hydraulic Analysis

Detailed hydrology and hydraulic models provided by Sacramento County were used to determine the inputs for EAD and IR analysis, which was performed using the US Army Corps of Engineers HEC-FDA model. For the ground contour elevations of the model, 2-ft contours provided by Sacramento County were used. The model datum is NGVD1929. Hydrologic and hydraulic inputs for the model were also obtained from Sacramento County. The hydrologic inputs were developed from the SacCalc model and were configured to use a 24-hour storm duration. The hydraulic inputs, namely the discharge-channel elevation function and channel elevation-floodplain elevation function, were developed using the HEC-

RAS and HEC-2 models. The development of the discharge-channel elevation function was developed through a series of steady-flow simulations, while unsteady-flow simulations were used to develop the channel elevation-floodplain elevation function.

Table 2 lists the annual exceedance probability and discharge at Unionhouse Creek river mile 1.75, while Table 3 shows the discharge and the water elevation both with and without the proposed project at Unionhouse Creek river mile 1.718.

Table 2: Discharge-Probability Function for Unionhouse Creek

Annual Exceedance Probability	Discharge (cfs)
0.999	400
0.5	949
0.2	1480
0.1	1804
0.04	2061
0.02	2200
0.01	2297
0.005	2333
0.002	2523

Table 3: Channel Discharge-Elevation Function for Unionhouse Creek

Discharge (cfs)	Elevation without Project (ft)	Elevation with Project (ft)
1	6.70	6.70
1000	17.04	15.35
1500	18.62	16.81
1600	18.93	17.14
1700	19.22	17.48
1800	19.52	17.77
1900	19.80	18.08
2000	20.07	18.40
2100	20.45	18.93
2200	20.90	19.56
2300	21.43	20.34
2400	21.65	21.15
2500	22.25	21.84
2600	23.01	22.73
2600	23.01	22.73

The north and south banks of Unionhouse Creek were broken into two sections for this analysis. The north bank of the creek was named IA 36 and the south bank was named IA 45 (Figure 3). Two channel elevation-floodplain elevation functions were developed, one for IA 36 and the other for IA 45. For IA 36, the non-damaging elevation threshold was found to be 19.5 feet; for IA 45, it was 19.7 feet.

Figure 3: Unionhouse Creek IR Benefit Analysis Study Area

Flood Prone Properties

Information regarding structure inventory inputs were developed based on information in the US Army Corps of Engineers *Draft Economic Reevaluation Report: American River Watershed Project, Folsom Dam Modification and Folsom Dam Raise Project*. A total of 4,272 structures were identified to be within the impact area (Figure 4). Of the 4,272 structures, 3,530 were 1-story single family homes, 684 were 2-story single family homes, 11 were 2-story multi-family homes and 47 were commercial buildings.

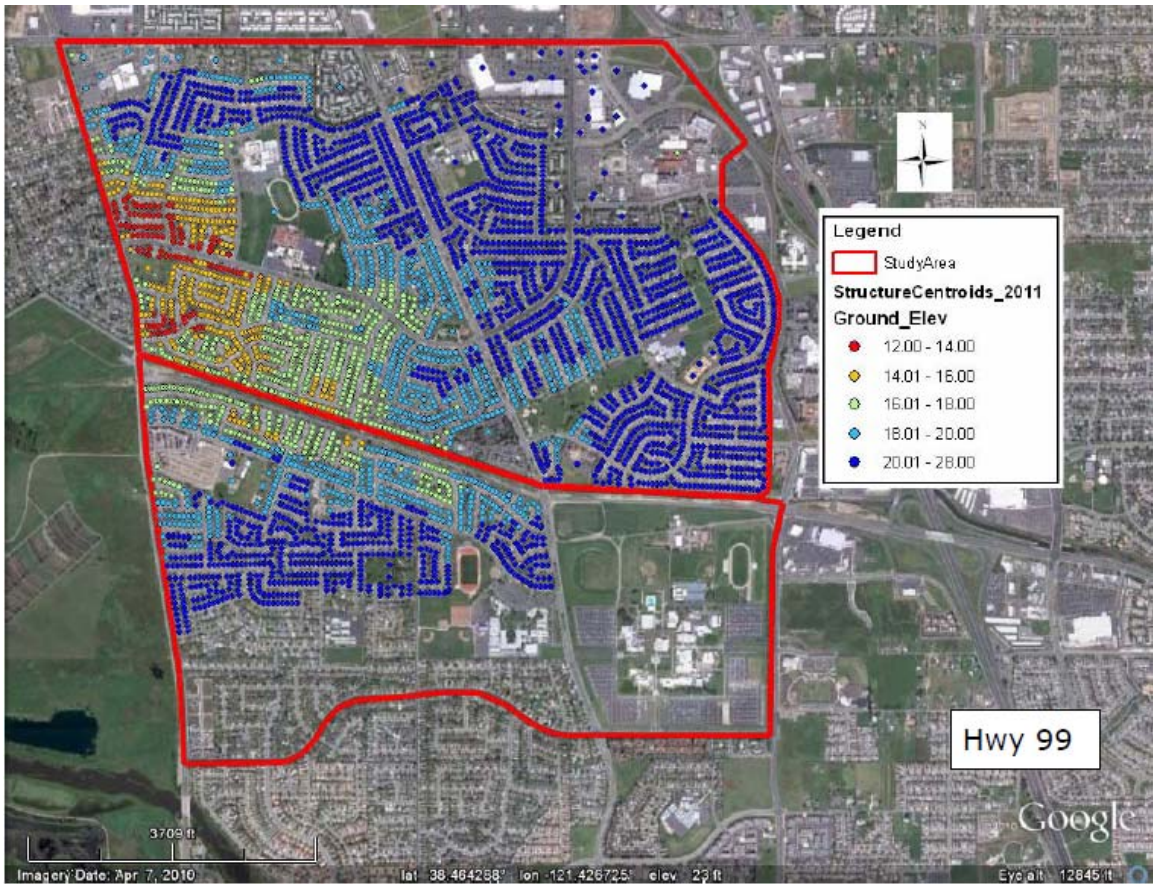

Figure 4: Structures Located in Unionhouse Creek Impact Area

The value of each structure was also obtained from the US Army Corps of Engineers *Draft Economic Reevaluation Report: American River Watershed Project, Folsom Dam Modification and Folsom Dam Raise Project*. Table 4 summarizes the structure and content values of the structures included in the analysis. The values shown in the table represent the total depreciated replacement value.

Table 4: Structure, Content, and Total Damageable Property Value by Structure Category

Structure Category	Structure Value ($1,000)	Content Value ($1,000)	Total Damageable Property ($1,000)
Single Family, 1 Story	$ 386,206	$ 193,103	$ 579,309
Single Family, 2 Story	$ 95,114	$ 47,557	$ 142,671
Multi-family, 2 Story	$ 108,542	$ 54,271	$ 162,813
Commercial	$ 224,430	$ 126,267	$ 350,697
Total	**$ 814,292**	**$ 421,198**	**$ 1,235,490**

Flood Damage Analysis

The flood damage analysis (FDA) was completed using HEC-FDA, a computer program developed by the US Army Corps of Engineers (USACE). HEC-FDA uses the stage and discharge data produced in HEC-RAS and structure information to develop damage-stage relationships and combines the damage-stage functions with discharge-exceedance probability and stage-discharge relationships. The model then applies a Monte Carlo simulation process to compute expected annual damage while accounting for uncertainty (See HEC-FDA User's Manual).

Depth-percent damage functions and the non-residential content depth-damage functions were consistent with the functions identified in the *Draft Economic Reevaluation Report: American River Watershed Project, Folsom Dam Modification and Folsom Dam Raise Project*. To convert the ground elevation to a first-floor elevation, a typical foundation value of 0.5 feet was use, which is consistent with previous assumptions.

HEC-FDA produced expected annual damage results based on the structural damage curves and flood model described in this memo. The EAD based on structural damage only is presented in Table 5.

Table 5: Expected Annual Damage based on structural damage curves

Scenario	Expected Annual Damage	Expected Annual Damage Reduced
Without Project	$530,000	--
With Project	$366,000	$164,000

Table 6 presents the present value of future benefits of the Project, assuming an analysis period of 50 years with a 6% discount rate, consistent with DWR standard practice. The results are presented in the following section.

Table 6: Present Value of Expected Annual Damage Benefits
(Referenced as Table 12 in Exhibit C of the Proposition 1E Grant PSP)

Expected Annual Damage Without Project	$530,000
Expected Annual Damage with Project	$366,000
Expected Damage Benefit	$164,000
Present Value Coefficient	15.76
Present Value of Future Benefits	***$2,587,000***

Conclusion

The Upper Unionhouse Creek Flood Protection Project will reduce the 100-year storm event stage height by approximately 1.1 feet and will provide an expected annual damage reduction of $164,000, which over the lifetime of the project results in a present value of $2,587,000. This is the result of removing 250 to 300 homes out of the inundation area. Additional benefits of this project are described in the Attachments 8-9, with a summary of all the benefits in Attachment 10.

Supporting Documentation

The following supporting documents are included in Attachment 3 this proposal:

- *Inundation-Reduction Benefit Analysis for Unionhouse Creek Memorandum* (David Ford Consulting Engineers, Inc., March 2011)
- *American River-Folsom Modifications Economic Analysis* (US Army Corps of Engineers, 2001)
- *American River Watershed, California Folsom Dam Modification Project, Final Limited Reevaluation Report* (US Army Corps of Engineers, August 2001)
- *American River Watershed, California Folsom Dam Modification Project, Draft Economic Reevaluation Project* (US Army Corps of Engineers , May 2007)